

Introduction to LabVIEW

Lawrence Berkeley National Lab – LabTech Day 2014

Chris Grabski

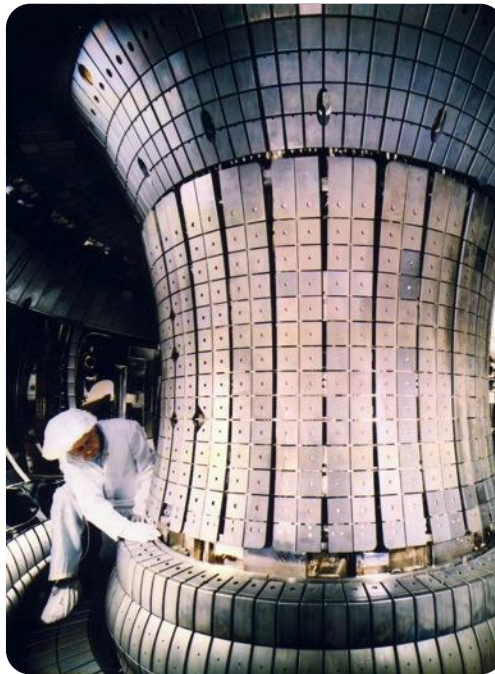
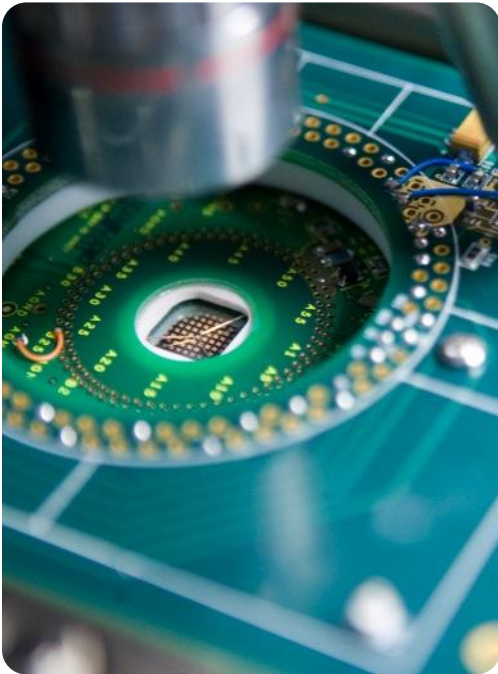
National Instruments – Field Engineer

Today's Agenda

- 9:00 – 9:50 AM – Introduction to LabVIEW
- 10:00 – 10:50 AM – The LabVIEW RIO Architecture
- 11:00 – 11:45 AM - NI Big Physics Applications

National Instruments: Our Mission

We equip engineers and scientists with tools that accelerate productivity, innovation, and discovery.



National Instruments at a Glance

Annual Revenue: \$1.14 billion

Global Operations:

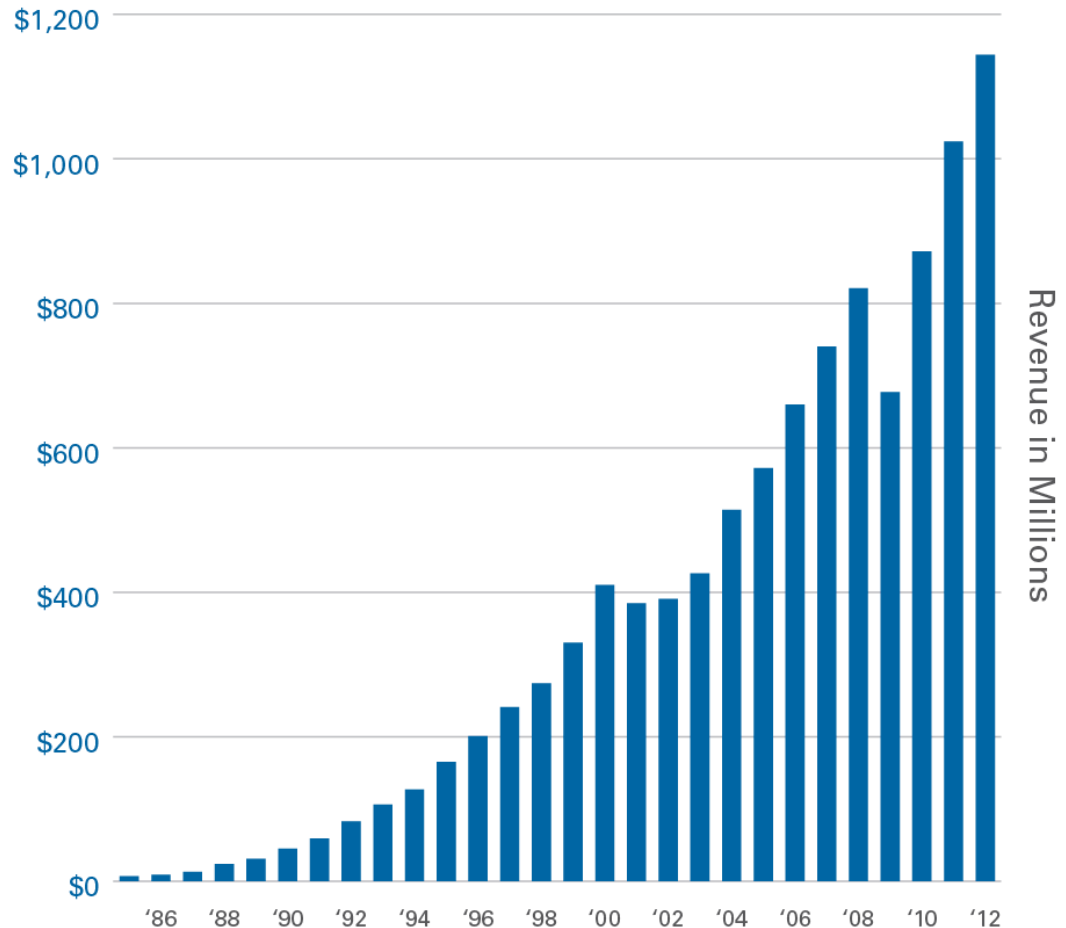
Approximately 7,100 employees;
operations in
more than 40 countries

Broad Customer Base: More
than 35,000 companies served
annually

Diversity: No industry >15%
of revenue

Culture: Ranked among the top
25 companies to work worldwide by
the Great Place to Work Institute

Strong Cash Position: Cash and
short-term investments of \$327
million
at March 31, 2013



Software

COMMUNITY

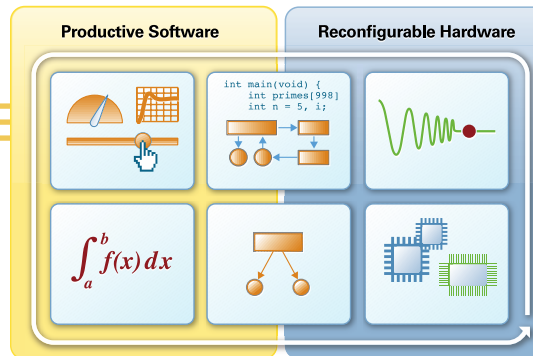
200,000+ online members
450+ registered user groups
3,000+ job postings online
8,000 classrooms using NI tools
74 peer-driven support forums

CONNECTIVITY

9000+ instrument drivers
8000+ example programs
1000+ motion drives
1000+ smart sensors
1000+ third-party PAC devices

COLLABORATION

100+ third-party add-ons
700+ alliance partners
1,000+ value-added resellers
35+ training courses



Hardware

Computing Technology

Intel, Microsoft, Freescale, Wind River
Multi-core and real-time technology

FPGA

Xilinx Virtex & Spartan
Reconfigurable hardware

IP

Control & signal processing IP & I/O
drivers
Built-in graphical IP, integrate user IP

I/O

Analog Devices, Texas Instruments
Connect to any sensor & actuator

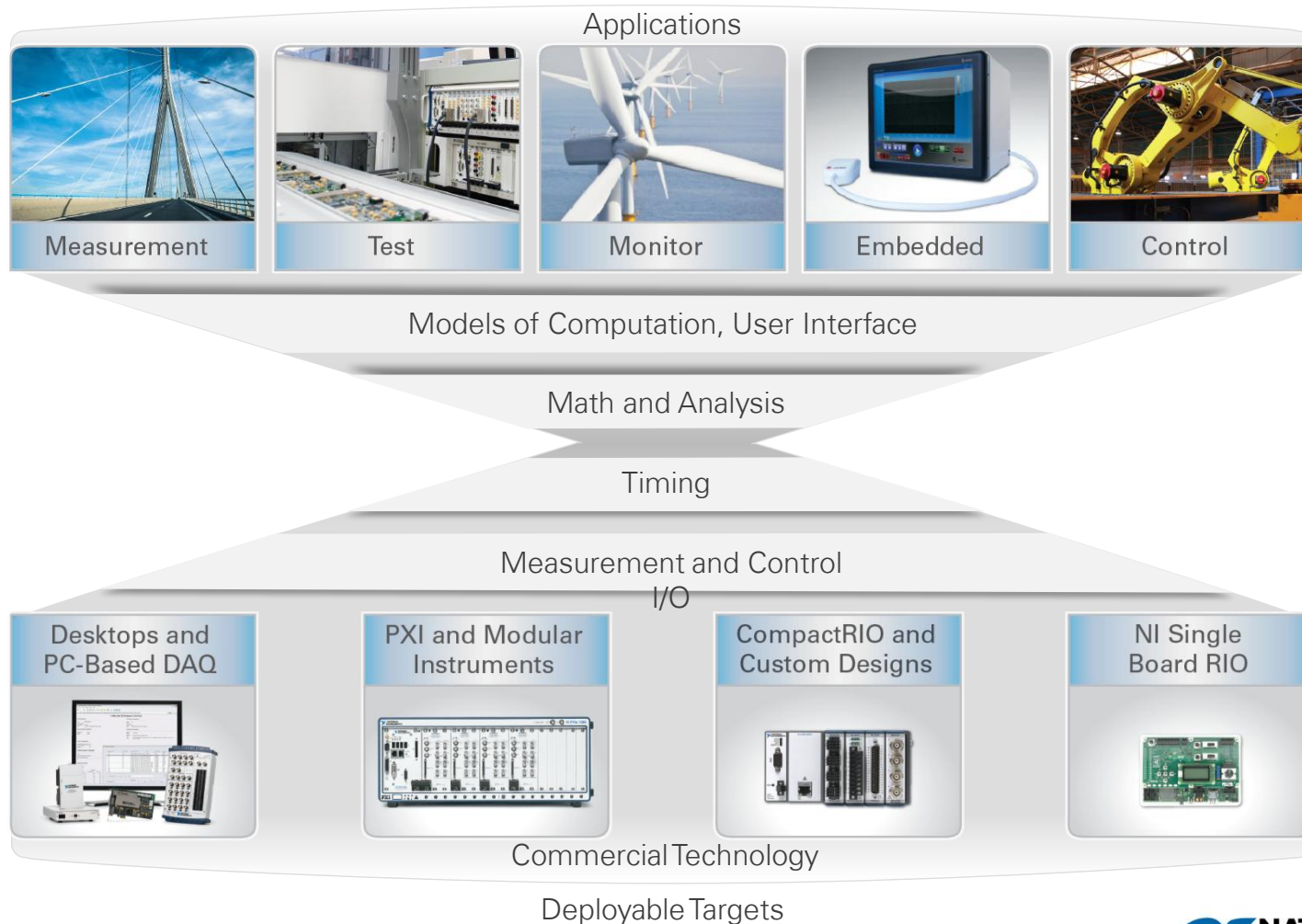
BUS

PCI/PCIe, Enet, USB, wireless,
deterministic Enet, Open architecture

World Class Technology
Ecosystem

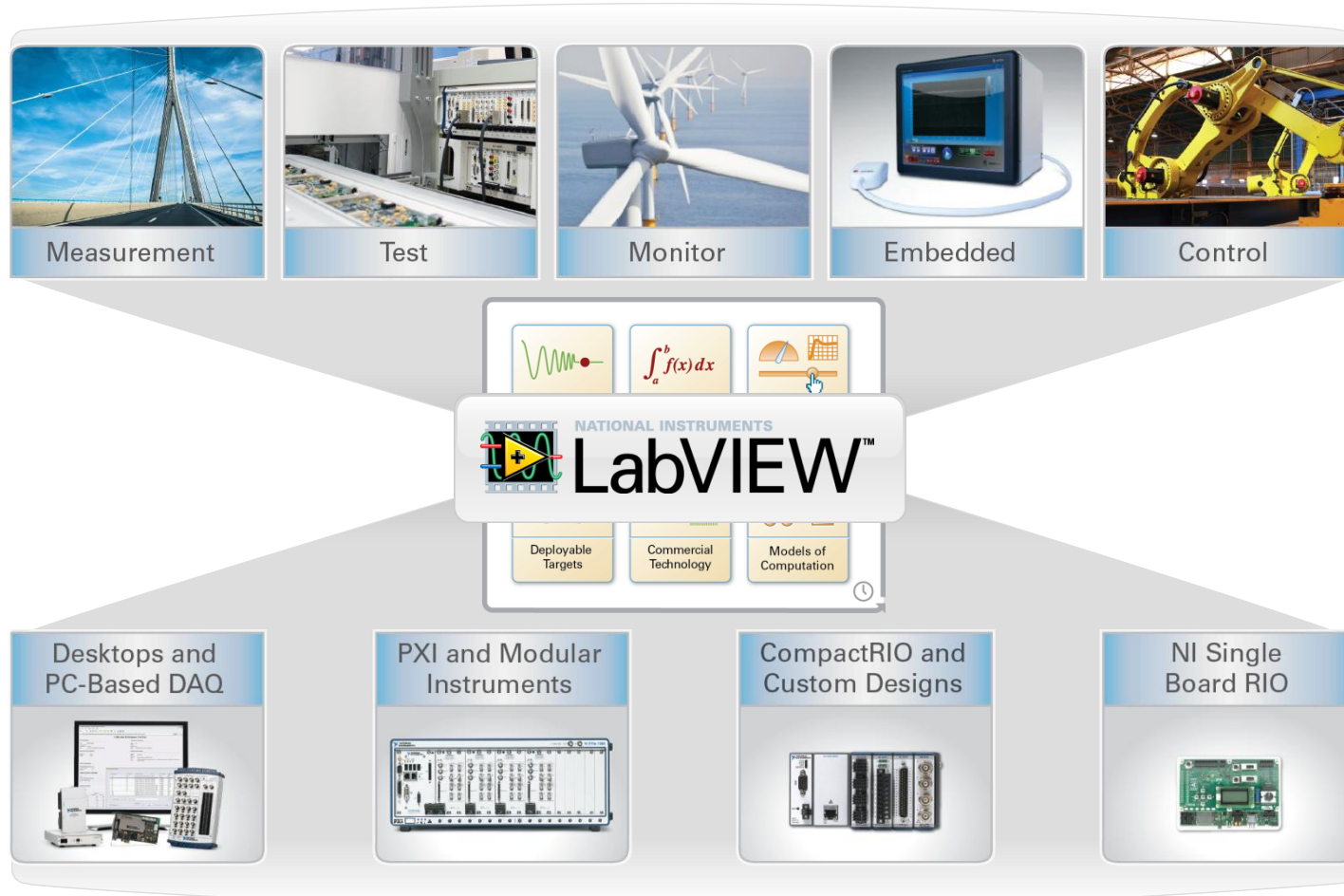
Graphical System Design

A platform-based approach for measurement and control



Graphical System Design

A platform-based approach for measurement and control



LabVIEW System Design Software

Project Explorer

Manage and organize all system resources, including I/O and deployment targets

Deployment Targets

Deploy LabVIEW code to the leading desktop, real-time, and FPGA hardware targets

Instant Compilation

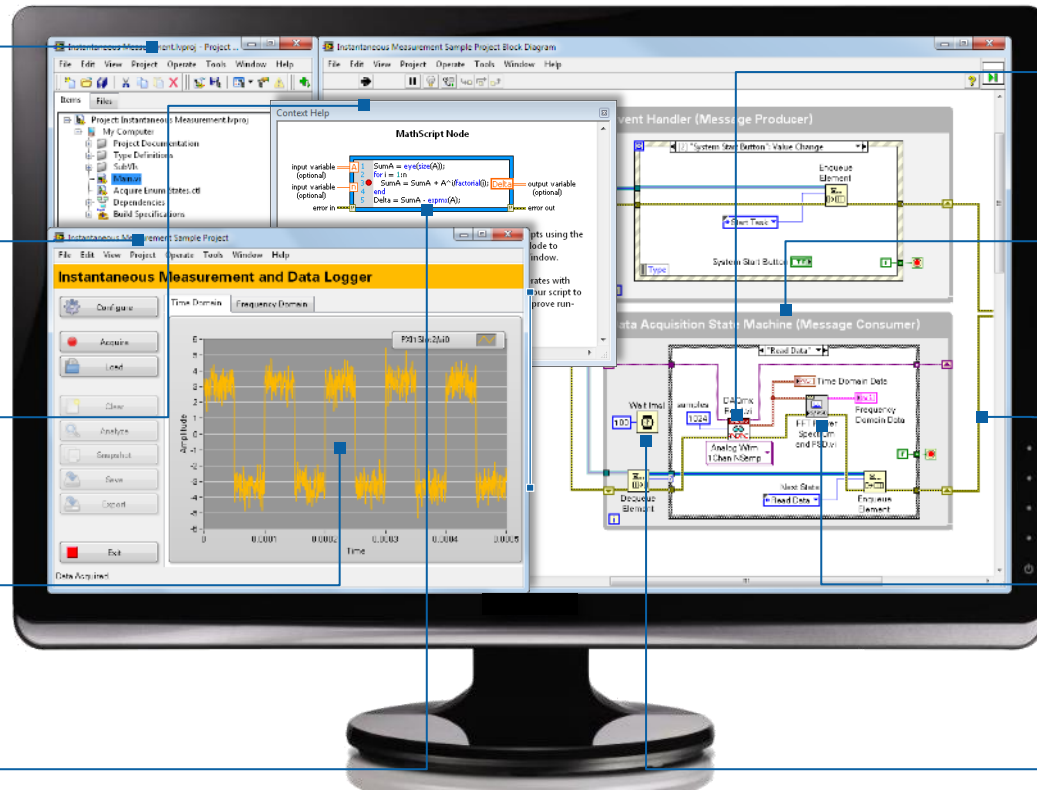
See the state of your application at all times, instantly

Front Panel

Create event-driven user interfaces to control systems and display measurements

Models of Computation

Combine and reuse .m files, C code, and HDL with graphical code



Hardware Connectivity

Bring real-world signals into LabVIEW from any I/O on any instrument

Parallel Programming

Create independent loops that automatically execute in parallel

Block Diagram

Define and customize the behavior of your system using graphical programming

Analysis Libraries

Use high-performance analysis libraries designed for engineering and science

Timing

Define explicit execution order and timing with sequential data flow

Accelerates Your Success

By abstracting low-level complexity and integrating all of the tools you need to build any measurement or control system

Integration of Modular I/O Hardware



Box Instruments



Modular Instruments

Complete NI PXI Instrumentation Portfolio

DAQ and Control

Multifunction I/O

FPGA / Reconfigurable I/O

Digital I/O

Analog Input / Output

Vision and Motion

Counter / Timer / Clock

Instruments

Oscilloscopes

High-Speed Digital I/O

Digital Multimeters

Signal Generators

Switching

RF Analyzers & Generators

Interfaces

GPIO, USB, LAN

RS232 / RS485

CAN, LIN, DeviceNet

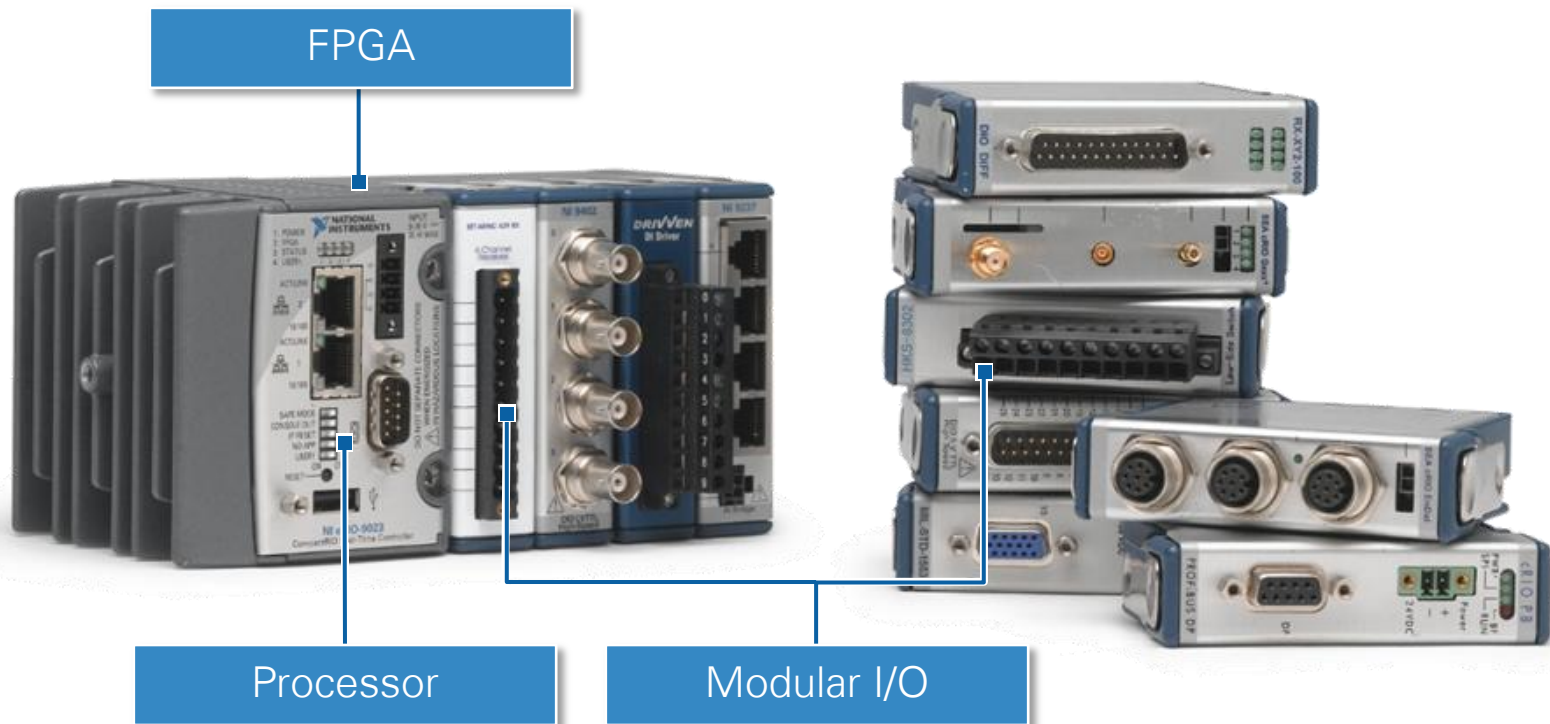
SCSI, Ethernet

VXI - VME

Boundary Scan / JTAG



NI CompactRIO

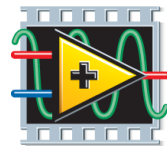


Introduction to LabVIEW

System Design Software for Any Measurement Application

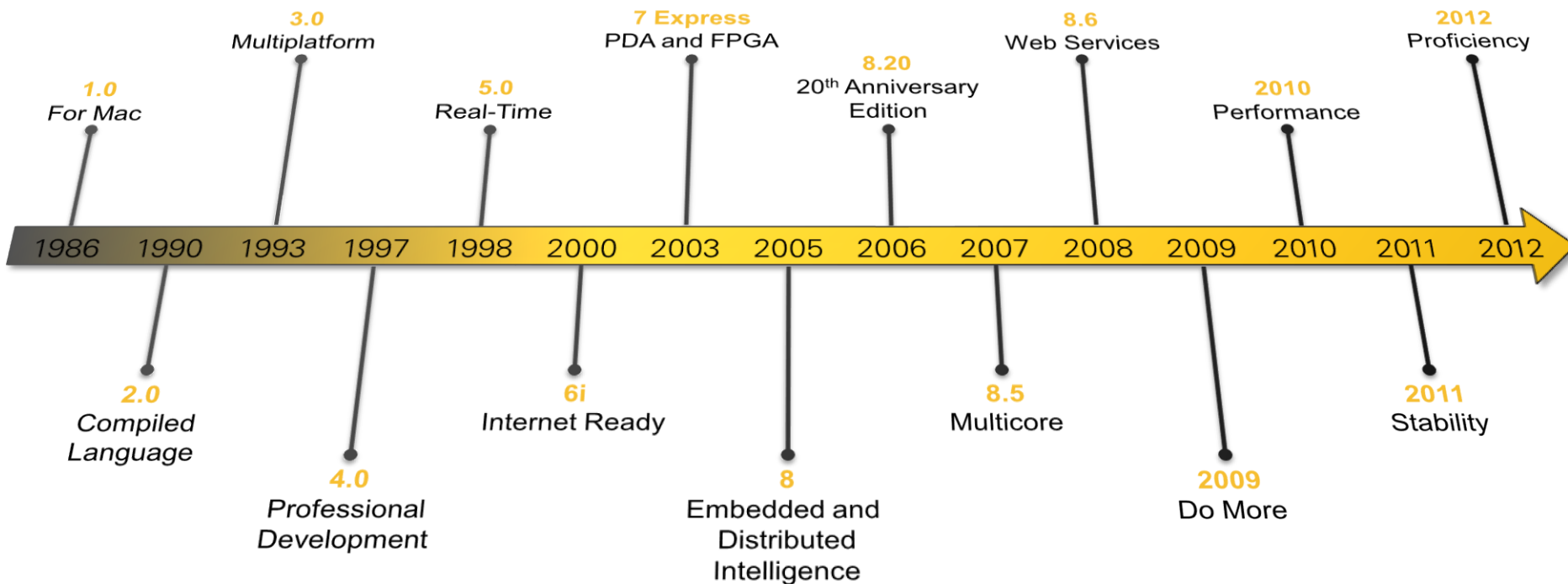
Because It Has Been Proven Over Nearly 30 Years...

Withstanding the test of time across operating systems, buses, technologies, and more



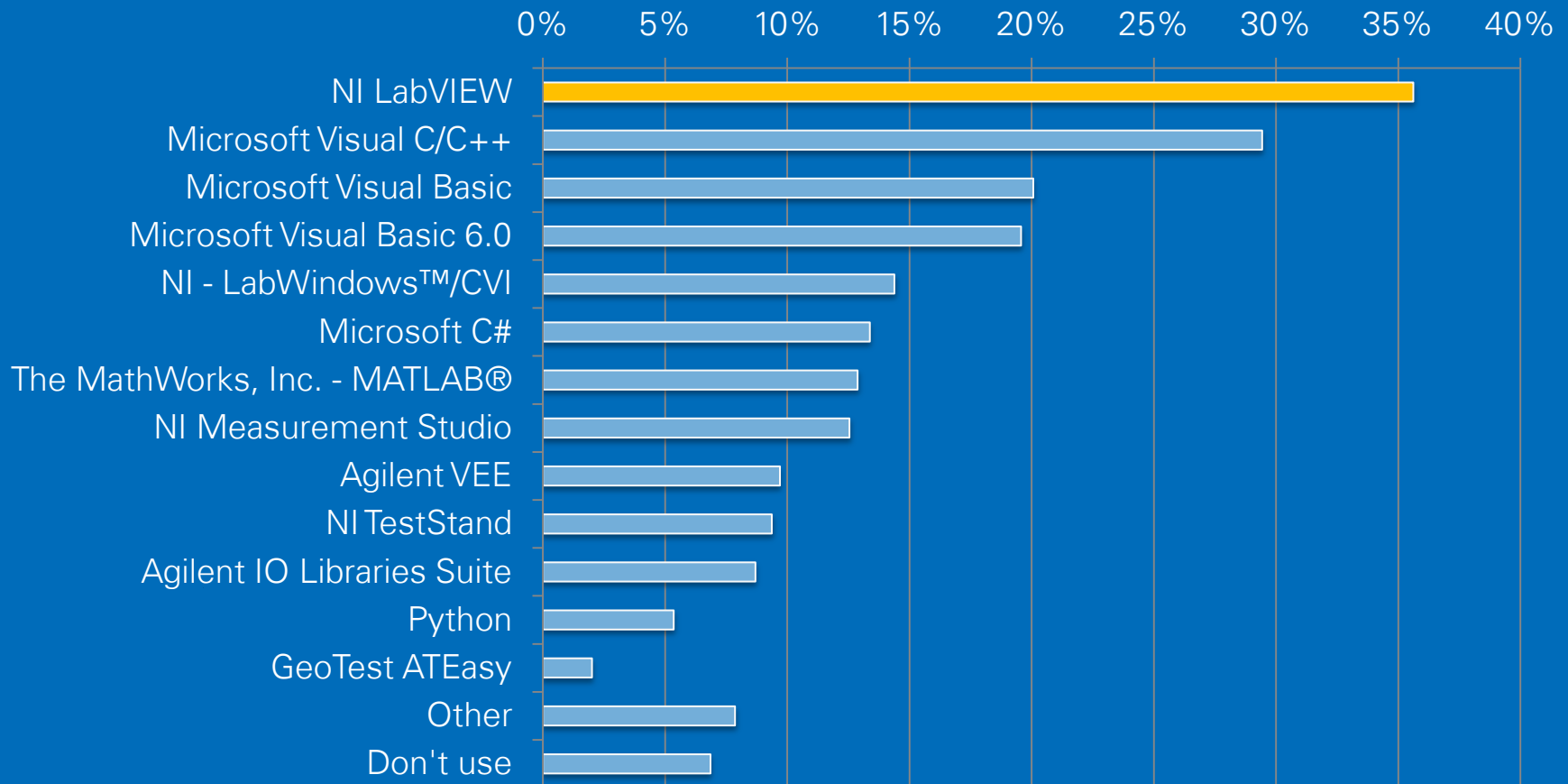
NATIONAL INSTRUMENTS

LabVIEW™



...LabVIEW Is the Standard for Making Measurements

Software Used for Data Acquisition and Instrument Control



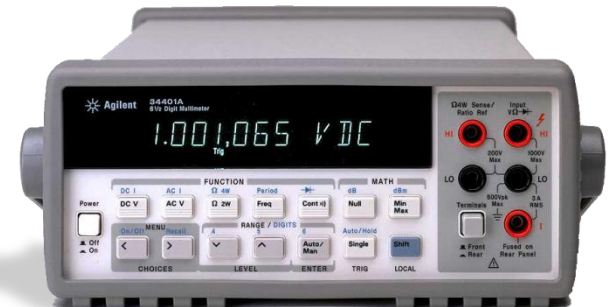
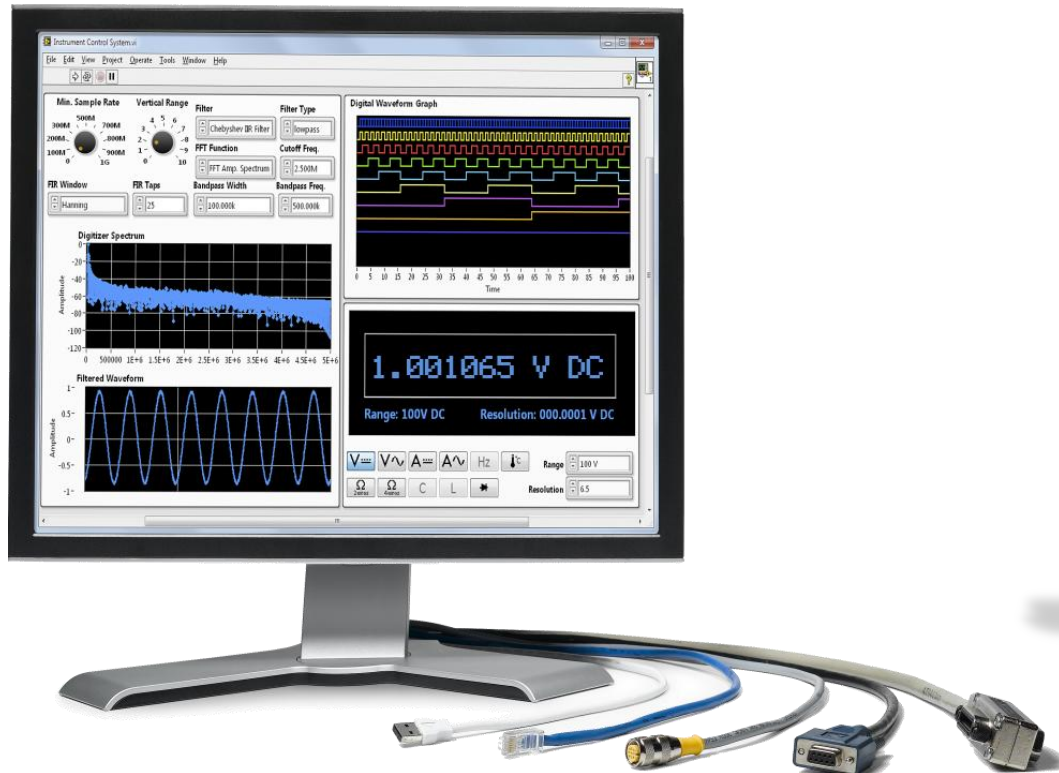
Unrivalled Hardware Integration in a Single Environment

- NI hardware
 - 200+ data acquisition devices
 - 450+ modular instruments
 - Cameras
 - Motion control
- Third-party hardware
 - Instrument Driver Network
 - 10,000+ instrument drivers
 - 350+ instrument vendors
 - 100+ instrument types
 - Communicate over any bus



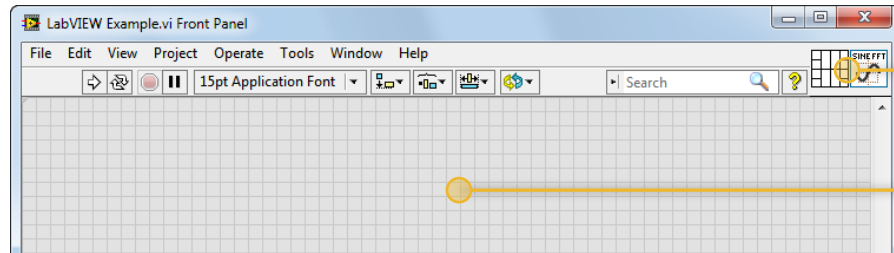
The Foundation of LabVIEW: Virtual Instrumentation

By leveraging COTS PC components, the **software** becomes the instrument



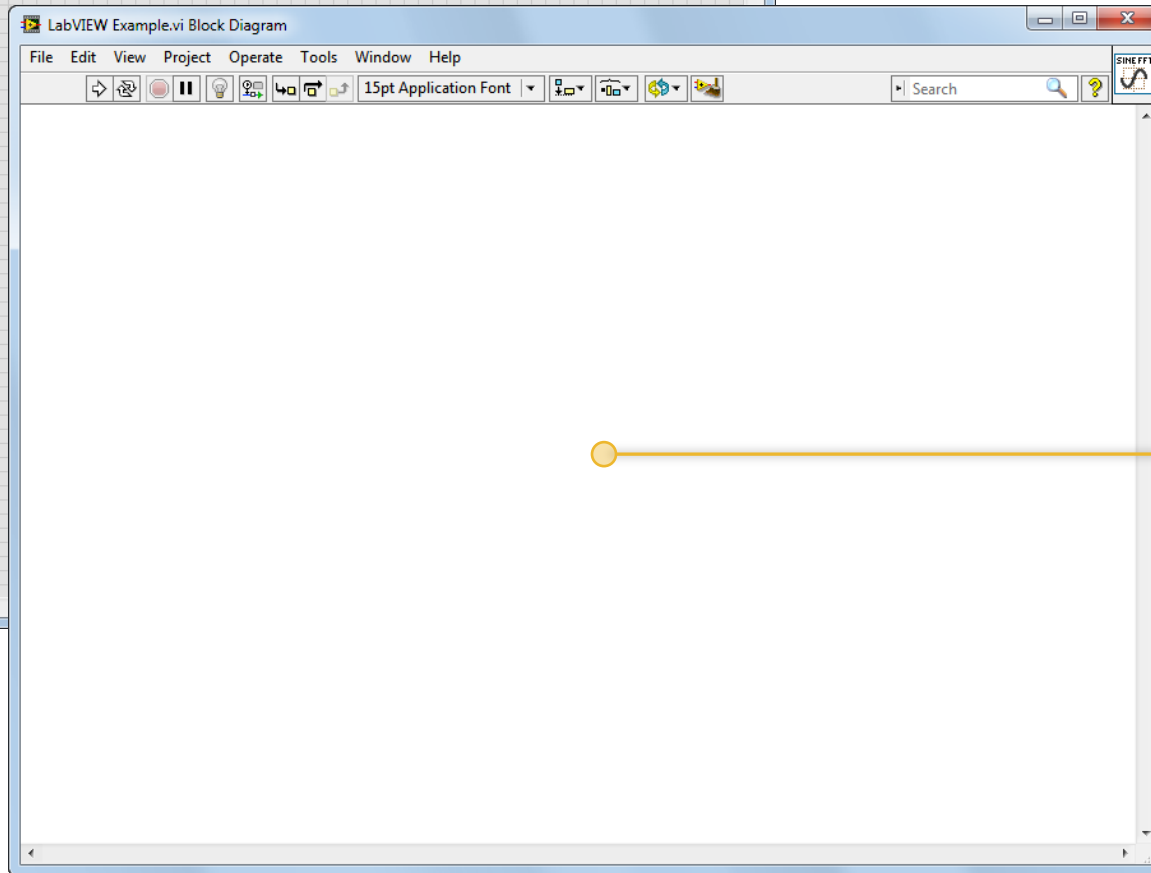
LabVIEW unlocks the power of instrument and data acquisition hardware by capitalizing on the PC industry and abstracting redundant circuitry.

Therefore, LabVIEW Building Blocks Are Called Virtual Instruments (*.VI)



Icon / Connector Pane
Maps inputs and outputs

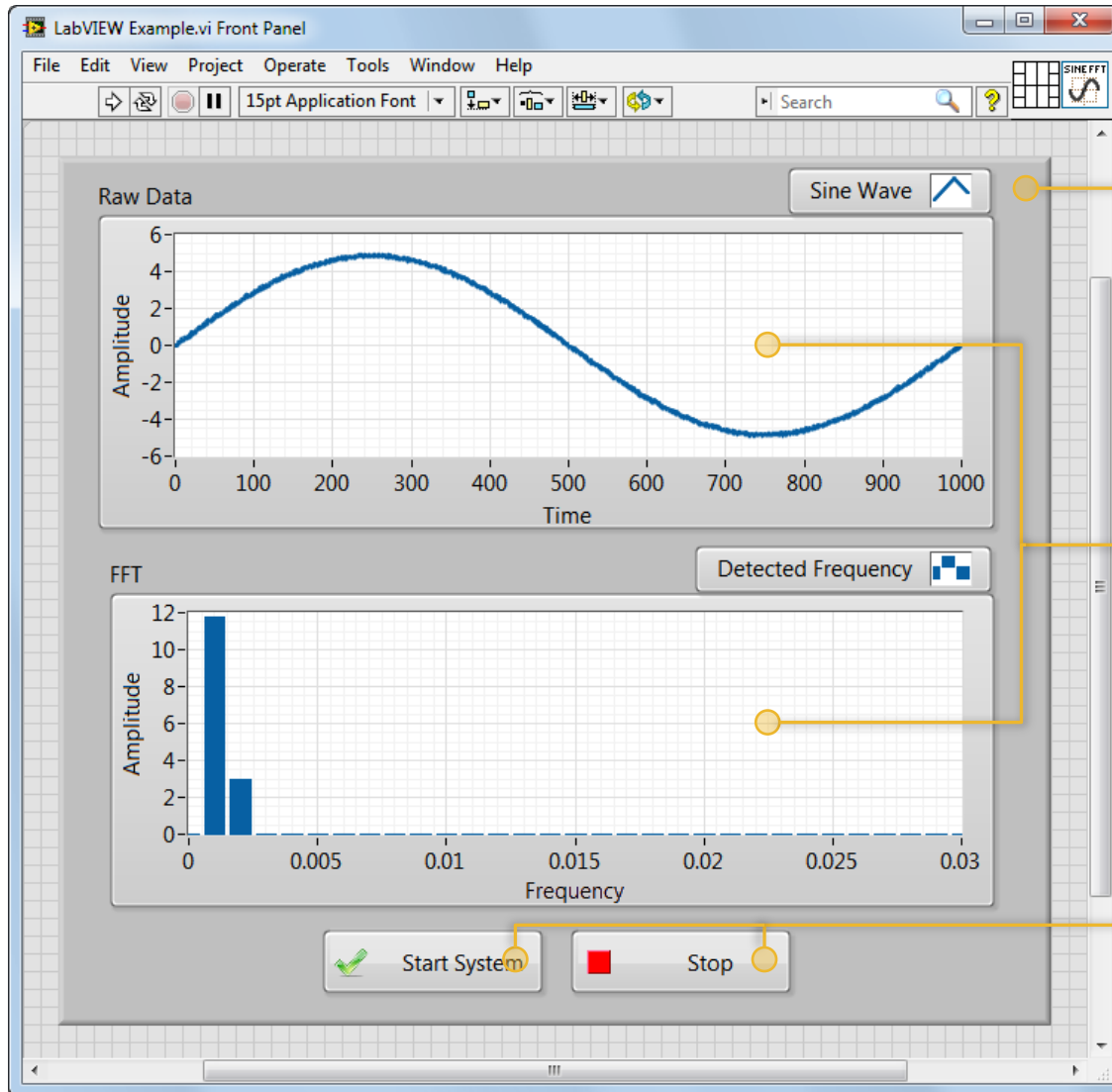
LabVIEW Front Panel
The user interface of a VI



LabVIEW Block Diagram
The source code of a VI

*Note: A *.vi file encapsulates all three elements*

Front Panel Objects



Decorations

Decorative elements and imagery

- Text
- Arrows
- Callouts
- Lines
- Images
- ...and more

Customizable Indicators

Used to convey outputs to a user

- Graphs and Charts
- Progress Bars
- Gauges and Meters
- LEDs
- Numerics
- Strings and Paths
- ...and more

Customizable Controls

Used to receive input from a user

- Knobs and Dials
- Sliders
- Buttons
- Numerics
- Strings and Paths
- ...and more

LabVIEW Front Panels in Action

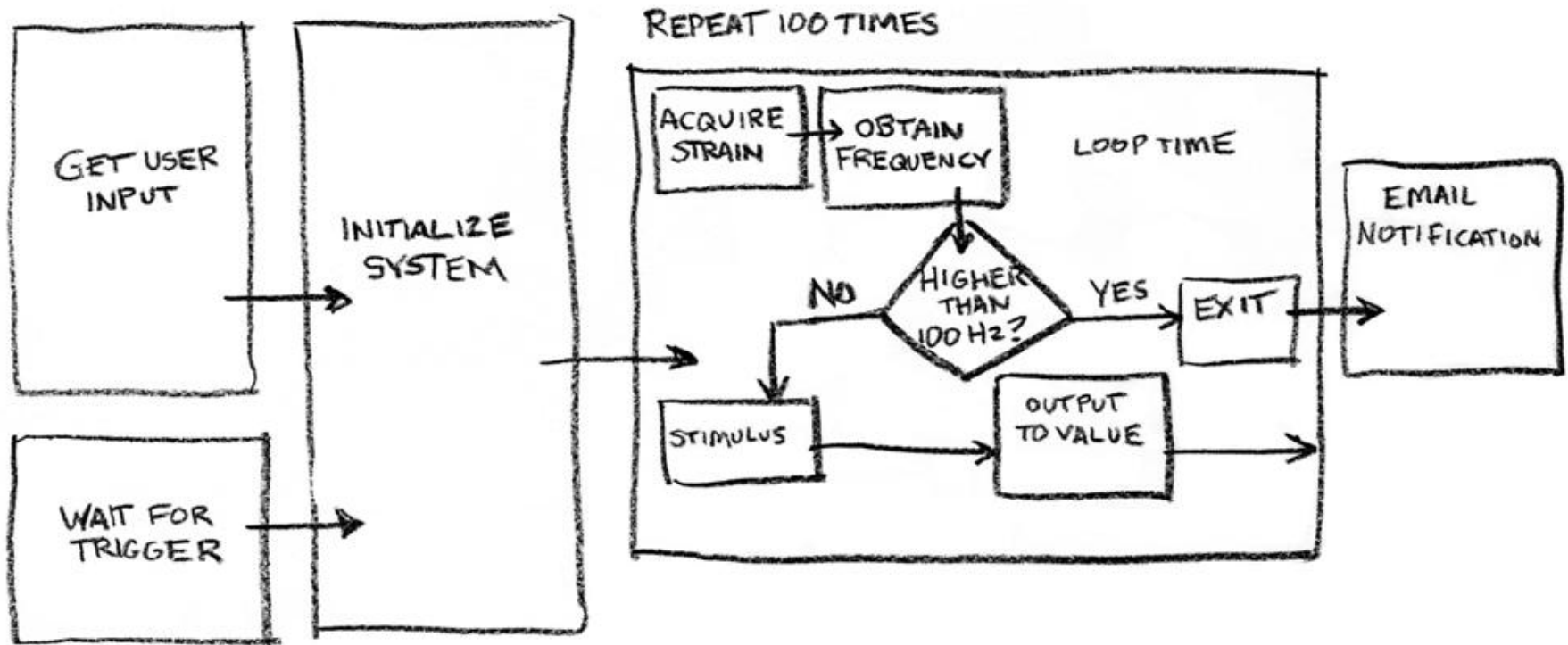


Dozens of LabVIEW front panels at SpaceX Mission Control during successful launch of Dragon
Photo Credit: Elon Musk

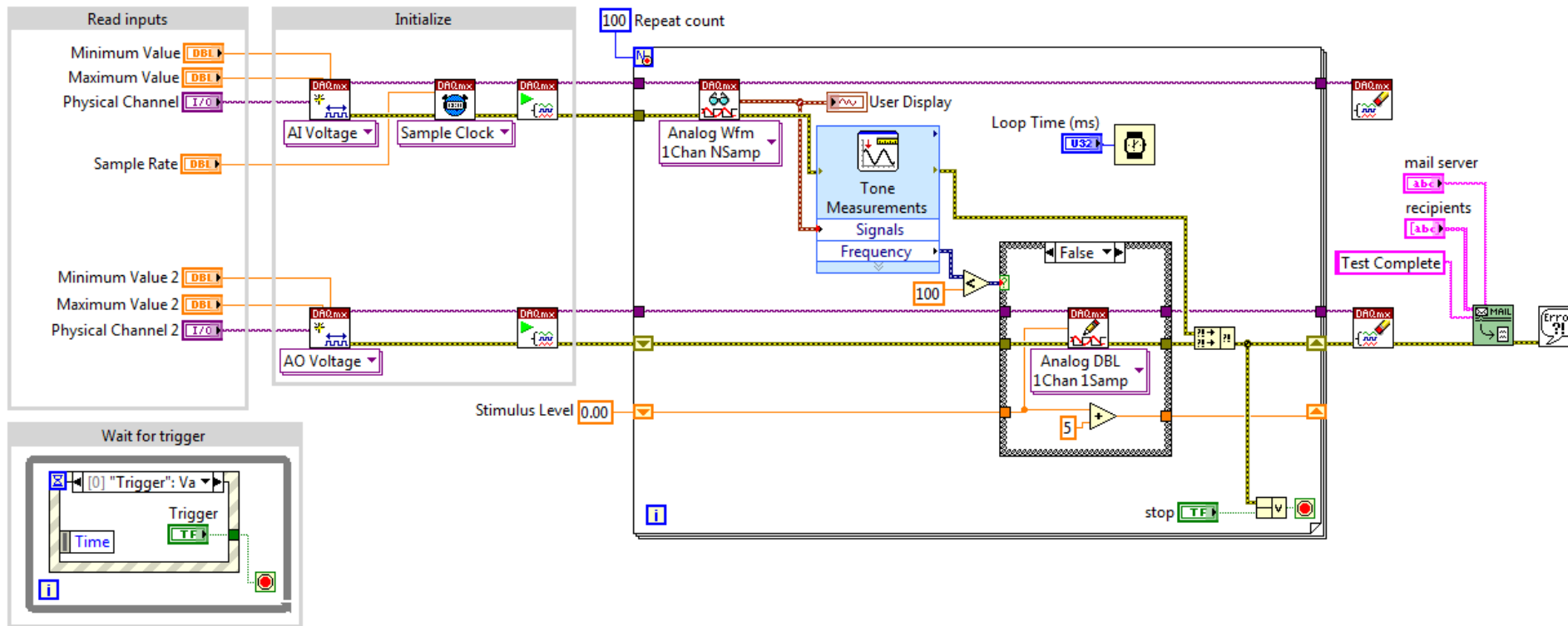


All of the front panels above were contributed for sharing and reuse by members of the global LabVIEW community.

With LabVIEW, You Can Program the Way You Think

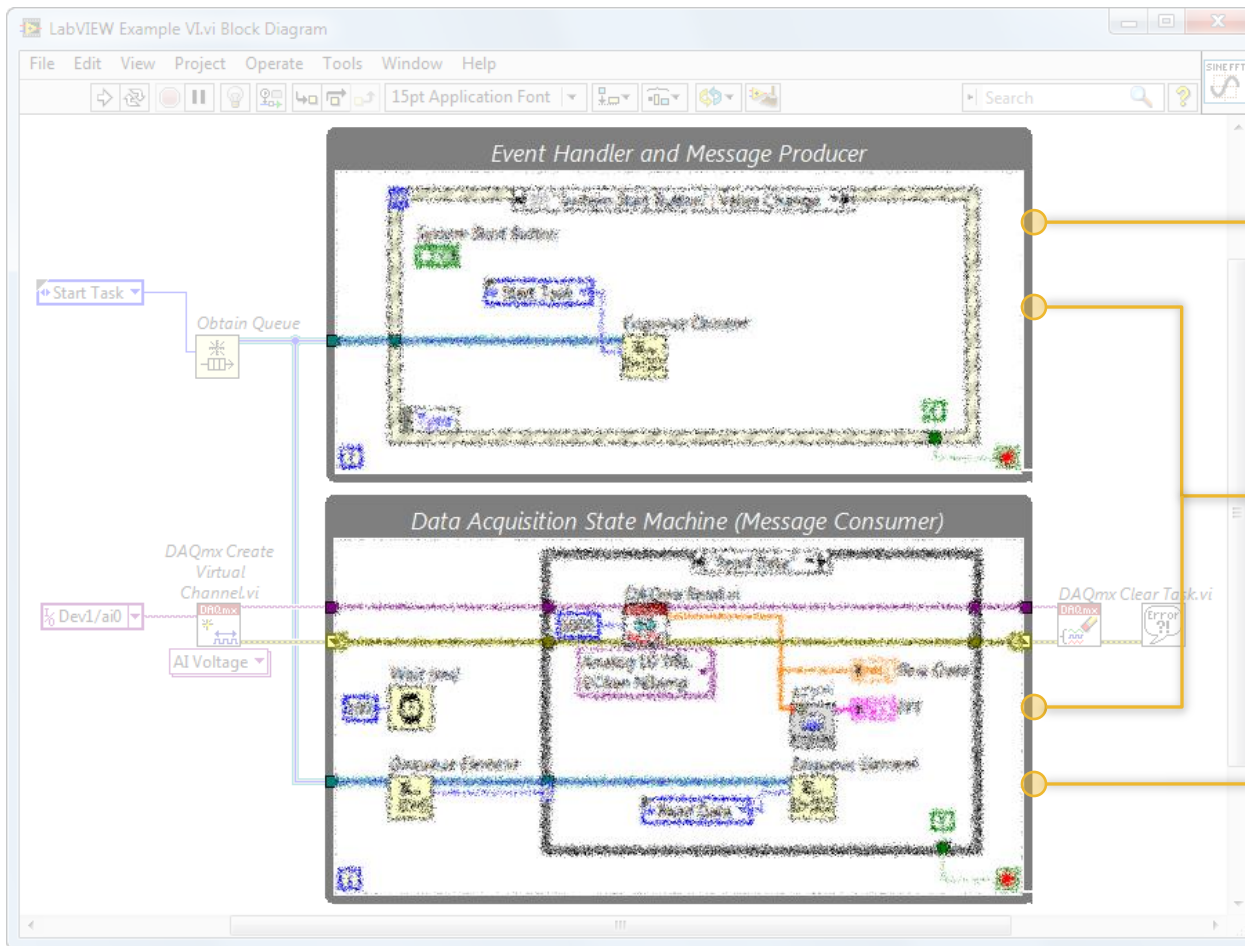


With LabVIEW, You Can Program the Way You Think



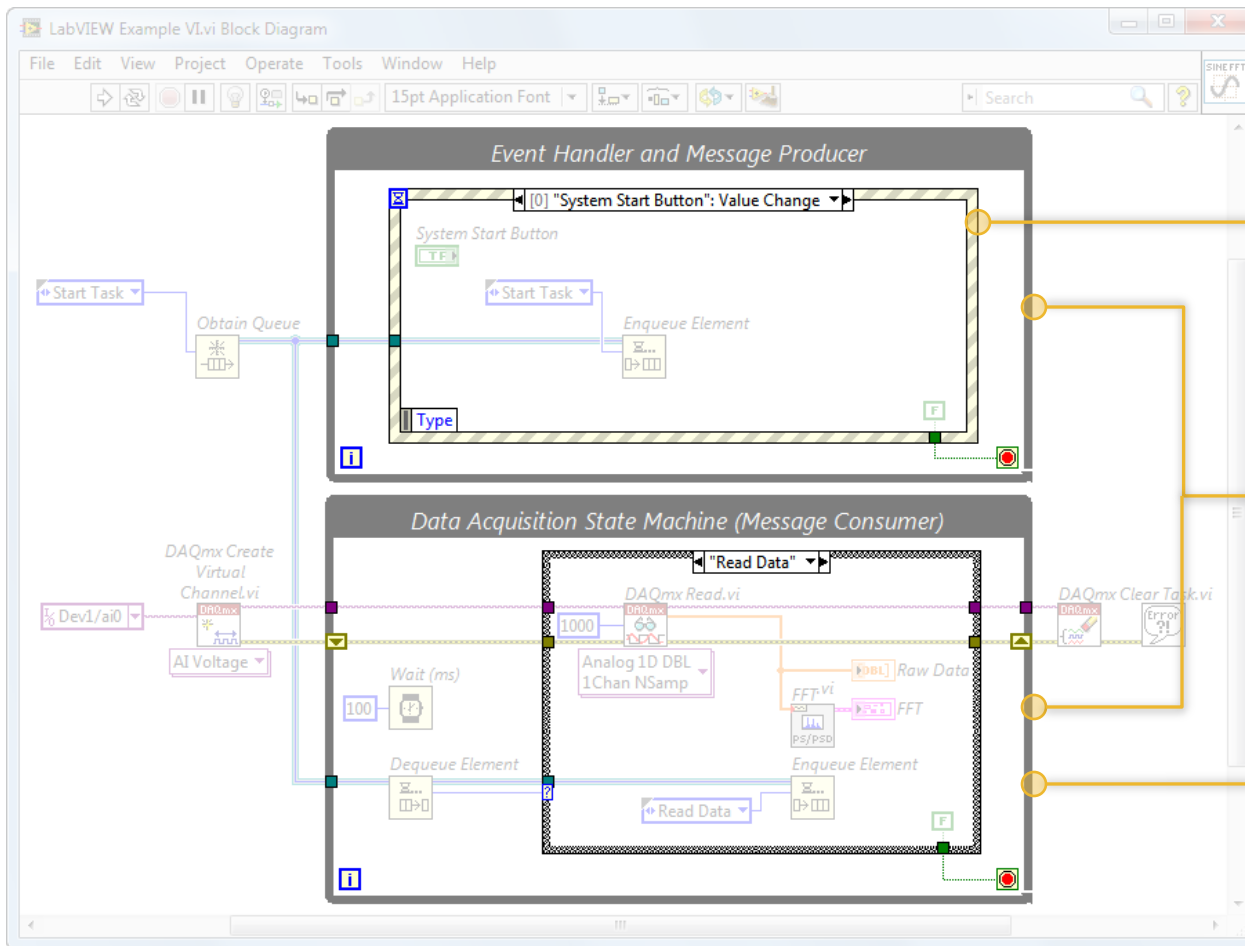
The graphical, **dataflow**-based G programming language is ideal for programming parallel data acquisition hardware.

Exploring a LabVIEW Block Diagram



Any block diagram entity that can contain code within it is called a **structure**.

Exploring a LabVIEW Block Diagram



Event Structure

Executes different subdiagrams based on events and interrupts

While Loops

Iterate continuously until a true value is passed to the stop terminal

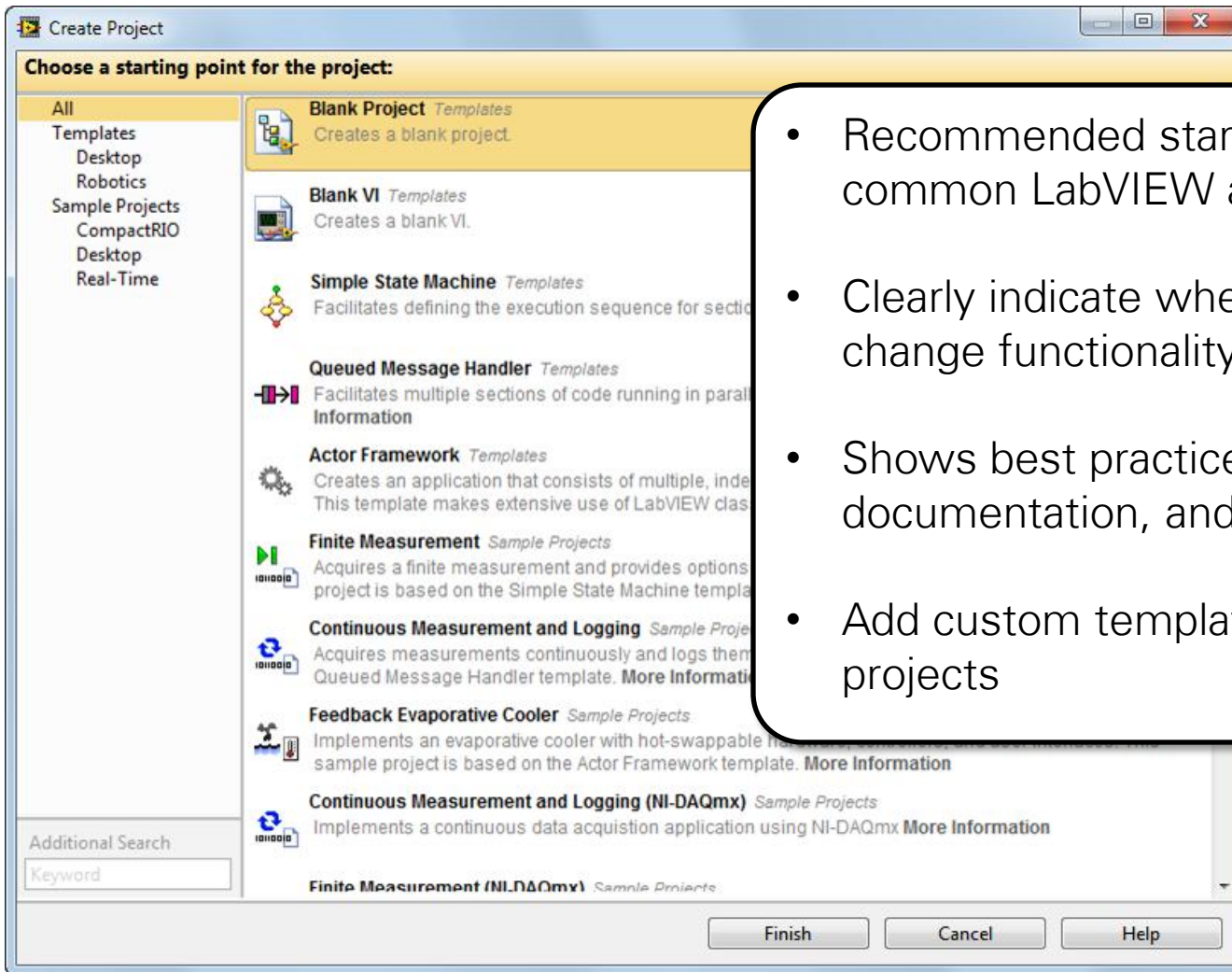
Case Structure

Executes different subdiagrams based on the value of its selector terminal

Demonstration

Never Start a LabVIEW Project From Scratch

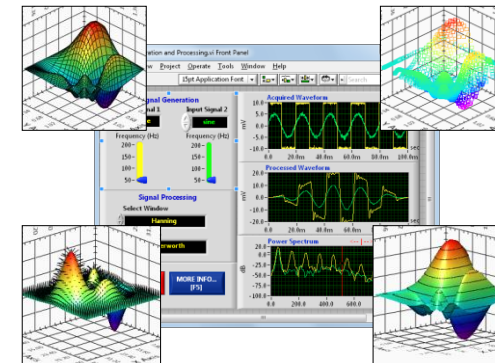
Abundant sample projects and templates provide a scalable starting point



- Recommended starting points for common LabVIEW applications
- Clearly indicate where to add or change functionality
- Shows best practices for code design, documentation, and organization
- Add custom templates and sample projects

Extending LabVIEW Beyond Data Acquisition

Express VIs	Spectral Measurements	Signal Processing and Math	Digital Filters and Banks	Measurements	Amplitude
	Distortion Measurements		Frequency and Time Domain		Distortion
	Tone Measurements		JTFA		Frequency Domain (Spectral)
	Amplitude and Level Measurements		Sampling, Re-Sampling		Noise
	Timing and Transition Measurements		Transforms		Phase Noise/Jitter Analysis
	Curve Fitting		Wavelets and Windowing		Power (AC) Measurements
	Filters		Signal and Waveform Generation		Pulse and Transition
	Statistics		Pulse and Pattern Generation		Sampling (Discrete Time) Concerns
	Convolution and Correlation		Basic Numeric Functions		Time Domain Analysis
	Signal Simulation		Curve Fitting and Data Modeling		Tone Detection
	Mask and Limit Testing		Differential Equations and Linear Algebra		Transient Signal Analysis
	Histogram		Interpolation and Optimization		
			Nonlinear Systems		
			Root Finding		
			Statistics and Random Processes		



Advanced Analysis

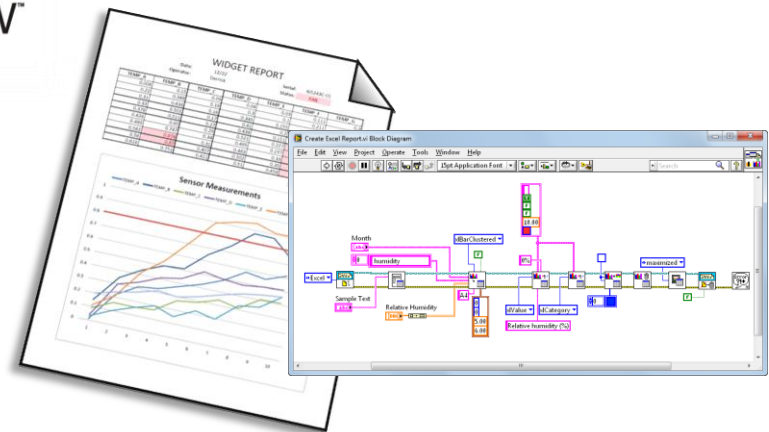
External Code Integration

Complex Visualization

Automated Reporting



.NET Assembly, C DLL, .m File



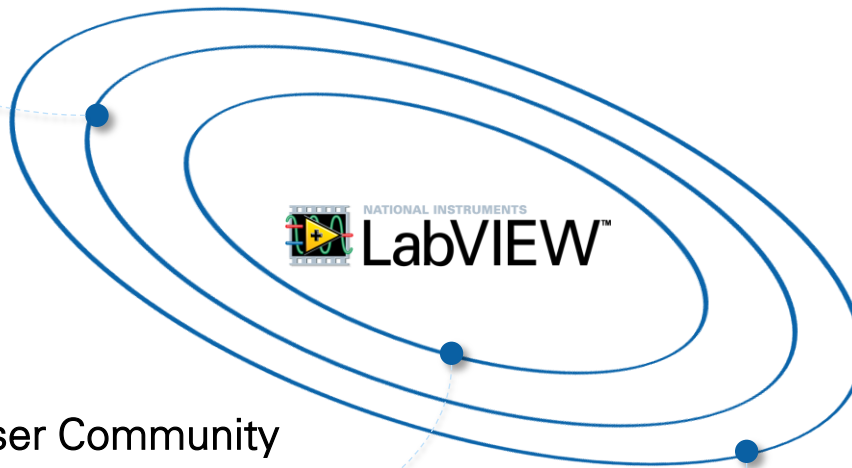
Leveraging the LabVIEW Ecosystem

LabVIEWTools Network

1,000,000+ Add-Ons Downloaded

26+ Certified Add-Ons

100+ Available Add-Ons



User Community

9,000+ Certified Users

700+ Alliance Partners

60+ Registered User Groups

Modules and Toolkits

40+ Toolkits and Modules Including:

- LabVIEW Real-Time Module
- LabVIEW FPGA Module
- LabVIEW Embedded Module for ARM
- LabVIEW Touch Panel Module
- LabVIEW Wireless Sensor Network Module
- LabVIEW C Code Generator
- NI Real-Time Hypervisor
- Vision Development Module for LabVIEW
- Sound and Vibration Measurement Suite
- Sound and Vibration Toolkit
- LabVIEW Advanced Signal Processing Toolkit
- LabVIEW Adaptive Filter Toolkit
- LabVIEW Digital Filter Design Toolkit
- LabVIEW MathScript RT Module
- Spectral Measurements Toolkit
- Modulation Toolkit for LabVIEW
- LabVIEW Robotics Module
- LabVIEW Biomedical Toolkit
- ECU Measurement and Calibration Toolkit
- GPS Simulation Toolkit for LabVIEW
- Measurement Suite for Fixed WiMAX
- WLAN Measurement Suite
- Automotive Diagnostic Command Set
- LabVIEW GPU Analysis Toolkit
- Multicore Analysis and Sparse Matrix Toolkit
- LabVIEW PID and Fuzzy Logic Toolkit
- LabVIEW Control Design and Simulation Module
- LabVIEW System Identification Toolkit
- LabVIEW Simulation Interface Toolkit
- LabVIEW SoftMotion Module
- LabVIEW Datalogging and Supervisory Control Module
- LabVIEW Report Generation Toolkit for Microsoft Office
- LabVIEW Database Connectivity Toolkit
- LabVIEW DataFinder Toolkit
- LabVIEW SignalExpress
- LabVIEW VI Analyzer Toolkit
- LabVIEW Statechart Module
- LabVIEW Desktop Execution Trace Toolkit
- NI Requirements Gateway
- NI Real-Time Execution Trace Toolkit
- LabVIEW Unit Test Framework Toolkit
- LabVIEW Application Builder for Windows

Questions